Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Use of Spectrum Bands Above 24 GHz For Mobile Radio Services	)	GN Docket No. 14-177
	)	
Establishing a More Flexible Framework to Facilitate Satellite Operations in the 27.5-28.35 GHz and 37.5-40 GHz Bands	)	IB Docket No. 15-256
	)	
Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42-43.5 GHz Band	)	RM-11664
	)	
Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95, and 101 To Establish Uniform License Renewal, Discontinuance of Operation, and Geographic Partitioning and Spectrum Disaggregation Rules and Policies for Certain Wireless Radio Services	)	WT Docket No. 10-112
	)	
Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operation	)	IB Docket No. 97-95

COMMENTS OF T-MOBILE USA, INC.

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COMMENTS OF T-MOBILE USA, INC.

T-Mobile USA, Inc. ("T-Mobile")[1/] submits these comments in response to the Further Notice of Proposed Rulemaking ("*FNPRM*")[2/] in the above-referenced proceedings, in which the

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[1/] T-Mobile USA, Inc. is a wholly-owned subsidiary of T-Mobile US, Inc., a publicly traded company.

Commission seeks comment on (i) making an additional 17.7 gigahertz of spectrum in the bands above 24 GHz available for the deployment of fifth generation ("5G") mobile wireless technologies, and (ii) various refinements to the rules adopted in July's *Report and Order*.[3/]

I. INTRODUCTION AND SUMMARY

Increasing use by consumers of data-intensive applications such as video and Internet access has resulted in significant, growing demand for mobile network capacity.[4/] As T-Mobile has noted in previous filings, spectrum above 24 GHz will play an important role in satisfying this demand, in particular by meeting the needs of small-cell deployment of 5G networks.[5/] However, although the *Report and Order* will make available 10.85 gigahertz of millimeter wave spectrum, only 3.25 gigahertz of this spectrum will be licensed on an exclusive basis and, of that, only a limited amount will be auctioned. The 28 GHz and 39 GHz bands are already heavily

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[2/] *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services; Establishing a More Flexible Framework to Facilitate Satellite Operations in the 27.5-28.35 GHz and 37.5-40 GHz Bands; Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42-43.5 GHz Band; Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42-43.5 GHz Band; Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0- 38.0 GHz and 40.0-40.5 GHz for Government Operations,* Report and Order and Further Notice of Proposed Rulemaking, FCC 16-89 (rel. July 14, 2016) (subparts referred to respectively as the "*Report and Order"* and the *"FNPRM*").

[3/] *Id*.

[4/] *See* CISCO, CISCO VISUAL NETWORKING INDEX: GLOBAL MOBILE DATA TRAFFIC FORECAST UPDATE, 2014–2019, at 17 (2015), http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.pdf ("Because mobile video content has much higher bit rates than other mobile content types, mobile video will generate much of the mobile traffic growth through 2019.").

[5/] *See* Comments of T-Mobile, GN Dkt. No. 14-177, at 5 (filed Jan. 27, 2016) ("T-Mobile Comments"); Kelly Hill, *Exploring the Role of Small Cells in 5G*, RCR WIRELESS NEWS (Mar. 24, 2015), http://www.rcrwireless.com/20150324/featured/small-cells-in-5g-tag6#prettyPhoto (discussing statements by Nokia Networks, SK Telecom, the Next Generation Mobile Network Alliance, and Ericsson's Radio Access Group stressing the importance of small cells for 5G networks).

licensed, and the spectrum is also subject to shared satellite use. As the Commission recognizes, this imbalance must be corrected.[6/] Exclusively licensed spectrum is essential for the robust future deployment of 5G technologies. Making spectrum available for licensed operations will encourage investment and technical innovation by providing carriers with necessary certainty. Deploying a network is a lengthy, complex process. T-Mobile therefore applauds the Commission's efforts with this *FNPRM* to begin the process of ensuring that additional millimeter wave band spectrum is available for licensed use.

In making allocation and licensing decisions, the Commission should limit federal/non-federal sharing, except where necessary to preserve existing operations or where it does not negatively impact the use of the bands for licensed operations, in order to maximize the opportunity for commercial use of the millimeter wave bands. It should also reject use of untested sharing techniques such spectrum access systems ("SAS") or use-it-or-share it approaches. Spectrum licensed to commercial providers on an exclusive geographic area basis has been the bedrock of the success of today's wireless ecosystem – one of the critical drivers of our nation's economy. The Commission should adopt rules that provide the greatest opportunity to extend that success.

II. THE COMMISSION SHOULD AUTHORIZE FLEXIBLE USE LICENSES IN ALL PROPOSED ADDITIONAL BANDS

In its comments earlier in this proceeding, T-Mobile recommended that the Commission look beyond the spectrum bands specified in the Notice of Proposed Rulemaking ("*NPRM*") for the capacity needed to meet the demand for 5G technologies.[7/] It therefore welcomes the

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6/ *See FNPRM*, ¶¶ 376 ("In view of these relative proportions, [the Commission] believe[s] it is appropriate to make additional licensed spectrum available for flexible use.").

7/ T-Mobile Comments at 4-6.

adoption of the *FNPRM,* which initiates the process of making additional spectrum available. Not all of the bands that the Commission is now considering – bands identified by the World Radio Conference as candidate bands for IMT-2020 (specifically, the 24.25-24.45 GHz and 24.75-25.25 GHz band ("24 GHz band"), 31.8-33.4 GHz band ("32 GHz band"), 42-42.5 GHz band ("42 GHz band"), 47.2-50.2 GHz band ("47 GHz band"), 50.4-52.6 GHz band ("50 GHz band"), and 71-76 GHz and 81-86 GHz bands ("70/80 GHz bands")) – met the Commission's initial criteria for consideration in the *NPRM*.[8/] However, as T-Mobile previously stated, and the Commission has now agreed, the Commission need not limit its consideration of millimeter wave bands to only those that have at least 500 megahertz of spectrum available and that are also under consideration internationally for millimeter wave mobile service.[9/] Rather, the Commission is correct to consider bands that do not meet these criteria, as "there are a wide variety of services . . . for which these bands could be used."[10/]

Additional Bands for 5G Operations. In addition to the bands that the Commission identifies, it should also consider the use of the 40-42 GHz band for terrestrial operations. The Commission adopted rules in the *Report and Order* governing the 37-40 GHz band and in the *FNPRM* and it proposes to designate the 42-42.5 GHz band for terrestrial use. Allowing mobile terrestrial operations in the 40-42 GHz band would create 5.5 GHz of contiguous spectrum for terrestrial wireless broadband. The 40-42 GHz band is currently designated principally for satellite operations under the Commission's "soft segmentation" plan.[11/] In the *Report and*

8/ *See FNPRM*, ¶¶ 372-73.

9/ *See* T-Mobile Comments at 4-5.

10/ *FNRPM*, ¶ 372.

11/ *See* U.S. Table of Frequency Allocations, 47 C.F.R. § 2.106; *Allocation and Designation of Spectrum for Fixed Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency*

Order, the Commission also permitted satellite use in the 37.5-40 GHz band, which will otherwise primarily be used for terrestrial services. Boeing, however, has petitioned that the conditions inherent in the soft segmentation plan be revised to allow greater satellite use of the 37.5-40 GHz band[12/] – specifically, Boeing requested an increase in the power flux density ("PFD") limit now applicable to the 37.5-40 GHz band.[13/] As T-Mobile details further below, the Commission should not increase this PFD limit. But, should the Commission chose to increase the PFD limit applicable to the 37.5-40 GHz band, the Commission should also re-visit its "soft segmentation" approach. In view of the needs of terrestrial mobile wireless systems, the Commission should at least take a similar approach to the 40-42 GHz band as to the 37.5-40 GHz band, and allow terrestrial use of a band that will be used for satellite operations.[14/] Further, if the Commission does not modify the current soft-segmentation arrangement and satellite operators find that it is not feasible to deploy services pursuant to the current arrangement, the Commission should reallocate the 40-42 GHz band to terrestrial mobile services rather than allow it to continue to lie fallow.

Bands, Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band, Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services, and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations, Second Report and Order, 18 FCC Rcd. 25428, ¶¶ 23- 24 (2003).

12/ *See* The Boeing Company Application, SAT-LOA-20160622-00058 (filed June 22, 2016) ("Boeing Application"); The Boeing Company Petition for Rulemaking, RM-11773 (filed June 22, 2016).

13/ *See FNPRM*, ¶ 498; Boeing Application.

14/ Any protection of adjacent channel operations can be addressed as suggested below, with respect to the 42-42.5 GHz band. In fact, because the 40-42 GHz band is further away from adjacent channel operations, there should be fewer concerns about potential interference.

Besides the 40-42 GHz band, the Commission should also consider the following spectrum for 5G operations, designated for study by the International Telecommunication Union ("ITU"):[15/]

- 25.25 – 27.5 GHz, which along with the 24 GHz and 28 GHz band would result in a contiguous 24.25 – 28.35 GHz band or about 4 GHz bandwidth;
- 42.5 – 43.5 GHz, which along with the 37 GHz, 39 GHz, and 40-42.5 GHz bands would result in a contiguous 37 – 43.5 GHz band or 6.5 GHz bandwidth; and
- 45.5 – 47.2 GHz, which along with 47 GHz and 50 GHz bands would result in a contiguous 45.5 – 52.6 GHz band or about 7 GHz bandwidth.

Framework for Access. While certain bands may require, either permanently or temporarily, protection of incumbent operations, those issues can likely be addressed through sharing, technical rules, and other accommodations, as they have been in spectrum auctioned for licensed mobile use.[16/] In fact, the AWS-3 transition and the corresponding work by the National Telecommunications and Information Administration's Commerce Spectrum Management Advisory Committee ("CSMAC")[17/] provides a valuable framework for how the Commission should proceed here with regard to incumbent federal users. Moreover, the propagation characteristics of the millimeter wave bands and accompanying enabling technologies such as electronic antenna steering – which can result in more intense spectrum re-use – can help facilitate federal/non-federal sharing. In light of the projected significant increase in mobile data

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15/ WORLD RADIOCOMMUNICATION CONFERENCE (WRC-15), FINAL ACTS, at 298 (2016), http://www.itu.int/opb/ecommercedownload/0015004772-40247-EN.pdf.

16/ *See, e.g., Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695- 1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands*, Report and Order, 29 FCC Rcd. 4610 (2014) (making available 40 megahertz of spectrum for commercial use pursuant to a coordination process between commercial and federal users).

17/ The NTIA chartered the CSMAC to advise it on spectrum-sharing arrangements for AWS-3 spectrum. In addition, CSMAC assisted the Wireless Telecommunications Bureau and NTIA staff in developing the coordination procedures for the AWS-3 transition.

traffic, even partial access to additional millimeter wave bands on a licensed basis, protecting incumbents as required, will help provide much needed network capacity.

Overview.

Application of Part 30 Rules and Geographic Licensing. The Commission proposes to apply the Part 30 technical rules to all of the bands referenced in the *FNPRM* [18/] and to license that spectrum, except for the 70/80 GHz bands, on a Partial Economic Area ("PEA") basis.[19/] For the 70/80 GHz bands, the Commission proposes "a licensing framework similar to the framework developed for the Citizens Broadband Radio Service."[20/] T-Mobile agrees that the Commission should apply the Part 30 rules to all target bands, which will generally allow for consistency throughout the millimeter wave spectrum, and that the Commission should license the 24 GHz, 32 GHz, 42 GHz, 47 GHz, and 50 GHz bands on a PEA basis, which would be consistent with the licensing of the 39 GHz band as well as other lower spectrum bands.[21/] The Commission should also adopt PEA-based geographic licensing for the 70/80 GHz bands. As T-Mobile noted above and in response to the *NPRM,* a disproportionate amount of millimeter wave band spectrum has been made available on a non-licensed basis and even that spectrum will not

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18/ *See FNPRM*, ¶ 377.

19/ *See FNPRM*, ¶ 375.

20/ *FNPRM*, ¶ 375.

21/ *See Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, 29 FCC Rcd. 6567, ¶ 71 (2014) (adopting PEAs as the service area for the 600 MHz Band licenses). T-Mobile recognizes that the Commission will license spectrum in the 28 GHz band on a county basis. Because licenses in that band were initially issued by Basic Trading Areas, which do not easily realign with PEAs, the Commission declined to also use PEA licensing for that spectrum. *See Report and Order*, ¶ 82. However, in other bands, the Commission should attempt to create a consistent licensing scheme using PEAs.

be fully available to new licensees.[22/] The Commission should rectify that imbalance here by, among other things, making the 70/80 GHz bands available on an exclusive licensed basis.

Spectrum Sharing. In contrast, the Commission should not extend the SAS concept adopted in the 3.5 GHz band to any of the target millimeter wave bands. Making spectrum available through database access remains untested. Until the Commission and users have more experience with this format, it should be limited to the bands already specified in the rules and not imported to the millimeter wave bands.

Federal Spectrum Use. Finally, the Commission should prioritize reallocation of spectrum from federal to non-federal use over options involving sharing between the two. While T-Mobile strongly supports ensuring that federal users have sufficient spectrum to perform their missions, sharing as a first option disserves both commercial and federal spectrum users. T-Mobile has successfully worked with incumbent federal entities to share spectrum – generally on a time-limited basis – for which it is the non-federal licensee. And, where there are current federal users, or where there is no impact on commercial access to the spectrum, T-Mobile supports spectrum sharing on either a permanent or temporary basis to maximize commercial access to spectrum; an option made easier, as noted above, based on the propagation characteristics and technology used in the millimeter wave bands.

However, where there is no or limited current use by federal users today, the Commission need not unnecessarily create a sharing mechanism in the absence of any demonstration by federal entities of a need for additional capacity in a target band. While there is ample evidence of the need for more commercial spectrum, Congress has recognized that federal users should be

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22/ T-Mobile Comments at 14.

vacating spectrum.[23/] And, where the Commission creates the opportunity for federal access to spectrum, it must do so in a way that makes the spectrum usable for commercial operations. In the *Report and Order,* the Commission recognized that unfettered satellite/terrestrial sharing would compromise the ability of terrestrial licensees to deploy ubiquitous networks.[24/] Similarly, where federal entities are permitted to share spectrum with non-federal users, the federal use must be limited in a manner that would not degrade the opportunity to deploy non-federal networks.

24 GHz Band (24.25-24.45 GHz and 24.75-25.25 GHz). Licenses in the 24 GHz band were most recently auctioned in 2004 on an Economic Area ("EA") basis, and only 7 of the 890 licenses offered were sold. Of these 7 auctioned licenses, only 5 are still active. FiberTower has 38 pre-auction Digital Electronic Messaging Service licenses. There are no federal allocations in the band, and the 24.75-25.25 GHz band is allocated for non-federal earth-to-space satellite services, limited to feeder links for the Broadcast Satellite Service ("BSS").[25/] The Commission proposes to add a mobile allocation to the 24.25-24.45 and 24.75-25.25 GHz segments of the 24 GHz band, a fixed allocation to 24.75-25.05 GHz and to authorize both mobile and fixed operations in those segments under the new Part 30 rules.[26/]

T-Mobile supports this proposal. The Commission acknowledges that satellite use of this band is limited by rule to BSS feeder links and that there are only four active licenses and one

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23/ *See, e.g.*, Middle Class Tax Relief and Job Creation Act of 2012, Public Law 112–96, 126 Stat. 156 (2012) (requiring that NTIA give priority to reallocation options that assign spectrum for exclusive, non-federal use over options that involve sharing when transitioning spectrum from federal to commercial use).

24/ *See FNPRM*, ¶¶ 48, 50-51.

25/ *See FNPRM*, ¶¶ 379-80.

26/ *See FNPRM*, ¶ 383.

pending application for feeder link earth stations in the 24.75-25.25 GHz band segment, all of which are held by DIRECTV.[27/] As the Commission suggests, there is a difference between BSS and general Fixed Satellite Service ("FSS") operations.[28/] In particular, BSS operations require fewer stations, and as noted above the existing rules only permit limited satellite use of the band. Accordingly, the Commission should keep in place the existing coordination procedures and limits in the 25.05-25.25 GHz band, and apply those same limits to the 24.75-25.05 GHz band, rather than adopting the sharing regime adopted for the 28 GHz band. The 28 GHz sharing scheme is intended to accommodate a type of ubiquity not needed for BSS operations and would be contrary to the existing BSS licensing scheme.

Band Plan/Block Sizes. As T-Mobile has stated before, block sizes in the millimeter wave bands must be proportional to the amount of spectrum available, take into consideration a band's location in the spectrum, and promote in-band competition where possible.[29/] T-Mobile therefore suggests that the Commission depart from what may otherwise be a standard 200 megahertz block size in the millimeter wave bands and license the 24 GHz band in seven 100 megahertz blocks. To adhere closely to a 200 megahertz block size, the Commission would be required to license the 24.25-24.45 GHz band as a single 200 megahertz block and the 24.75-25.25 GHz band as two 250 megahertz blocks.[30/] However, this approach will limit the number of potential entrants to the band.

27/ *See FNPRM*, ¶ 380.

28/ *See FNPRM*, ¶¶ 380, 384.

29/ *See* T-Mobile Comments at 11; Reply Comments of T-Mobile, GN Dkt. No. 14-177, at 12 (filed Feb. 26, 2016) ("T-Mobile Reply Comments").

30/ *See FNPRM*, ¶ 385. T-Mobile has historically supported smaller block sizes to promote competition. *See, e.g.,* Comments of T-Mobile USA, Inc., GN Docket No. 13-185, 28 (filed Sep. 18,

Mobile Rights. T-Mobile endorses the Commission's proposals to grant mobile rights to the existing fixed licensees and to make new fixed and mobile authorizations co-primary with FSS,[31/] while continuing the limited FSS use of the band for BSS operations only. As with the 28 and 39 GHz bands, incumbent licenses should be converted to Upper Microwave Flexible Use Service ("UMFUS") licenses, and licensees should be given the option to repack consistent with the new band plan.

32 GHz Band (31.8-33.4 GHz). The entire 32 GHz band is currently allocated for the Federal Radionavigation Service. The 32.3-33.4 GHz band is allocated for the non-federal Radionavigation Service, and the 32.3-33 GHz band is allocated for Inter-Satellite Service. In addition, the 31.8-32.3 GHz portion of the band is currently used only in Goldstone, California for space-to-earth space research.[32/]

Adding a Mobile Allocation. T-Mobile supports the Commission's proposal to add primary non-Federal fixed and mobile service allocations to the 32 GHz band under the new Part 30 rules.[33/] The Commission observes that there are two challenges to authorizing the band for 5G services.[34/] First, it is not currently allocated for mobile use. However, as T-Mobile has previously advocated, even where there is not a current mobile allocation for the band, the Commission should consider reallocation and take an international leadership role in evaluation

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2013) ("T-Mobile supports the Commission's proposal to license the AWS-3 spectrum using five megahertz blocks.").

31/ *See FNPRM*, ¶ 383.

32/ *See FNPRM*, ¶ 386-87. Other restrictions are contained in footnotes to the Table of Allocations.

33/ *See FNPRM*, ¶ 389.

34/ *See FNPRM*, ¶ 388.

of the band for potential mobile use.[35/] The Commission has correctly determined to depart from the current international scheme in the 28 GHz band and should do the same here. There is no evidence that U.S. use of the 32 GHz band will impede other countries' use of the spectrum.

Protection of Co-Channel and Adjacent Channel Operations. Second, the Commission points out that 5G operations must protect existing co-channel and adjacent channel operations.[36/] However, non-federal fixed and mobile service can be deployed in a manner that protects adjacent radioastronomy service ("RAS") operations through use of exclusion and coordination zones. In the 3.5 GHz band, the Commission has employed exclusion zones and geographic separation to prevent radar systems and broadband wireless operations from causing interference to one another.[37/] That same methodology can be applied to protect radionavigation systems in the 32 GHz band. In fact, shorter propagation distances of the 32 GHz band compared to the 3.5 GHz band, could result in smaller exclusion zones and easier interference coordination.

Based on the small number of and known remote fixed locations of RAS sites, providing protection through geographic separation, considering terrain characteristics and other network implementation capabilities, offers the most effective means of maximizing spectrum access in the 31.3-31.8 GHz band.[38/] Direct discussions with RAS operators regarding the specific sites

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35/ *See, e.g.,* T-Mobile Reply Comments at 5 ("[T]he Commission can and should take a leadership position by adopting rules for the [28 GHz[] band to support terrestrial wireless operations that the rest of the world can follow.").

36/ *See FNPRM*, ¶ 388.

37/ *See Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band,* Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd. 3959, ¶¶ 258-68 (2015).

38/ **Appendix A** shows the footnotes to the Table of Allocations which list the locations of RAS operations that require protection.

should be pursued to determine exclusion or coordination zones. Recommendations on the extent of exclusion zones and specific coordination methodologies will depend on information about the existing and planned non-federal uses of radar in this band through such discussions. In contrast, establishing guard bands to protect the 31.3-31.8 GHz band would be inefficient and overprotective.[39/]

Band Plan/Block Size. The Commission should license this spectrum in 200 megahertz-wide channels, consistent with the band plans for the 37 and 29 GHz bands. With 1600 megahertz of spectrum available, there is sufficient bandwidth to create multiple licensees in the band.

42 GHz Band (42-42.5 GHz). The 42 GHz band is currently allocated for non-federal fixed and mobile use, but the Commission has not yet adopted service rules for terrestrial service. The adjacent band, 42.5-43.5 GHz, is allocated for federal and non-federal RAS operations and federal fixed, earth-to-space satellite and mobile services.[40/]

Protection of RAS Operations. T-Mobile supports the Commission's proposal to authorize fixed and mobile operations in the 42 GHz band under the Part 30 rules, subject to protections for adjacent-band RAS operations.[41/] Recent history suggests that commercial users can operate in a manner that protects the operations of even those federal agencies with the most sensitive communications.[42/] There are PFD limits adopted through Recommendations by the

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39/ To the extent the Commission considers guard bands, they should be confined to specific, limited, geographic areas where coordination or exclusion is necessary.

40/ *See FNPRM*, ¶ 400.

41/ *See FNPRM*, ¶ 403.

42/ For instance, in the 3.5 GHz proceeding, the Commission adopted rules for shared commercial and federal use of the 3550-3700 MHz band, 100 megahertz of which (3550 MHz-3650 MHz) was previously allocated for Department of Defense radar systems. *See Amendment of the Commission's Rules*

ITU specifically intended to protect RAS operations from terrestrial operations.[43/] Commission adoption of these PFD limits will address potential interference to RAS.

Moreover, current analyses regarding interference to RAS receivers in the high frequency range have focused on satellite services, concluding that satellite transmissions and airborne terrestrial operations have the greatest potential to cause severe interference to the RAS.[44/] Ground-based terrestrial interference sources are usually in the far side-lobe region of the radio telescope antenna, and possibly further attenuated by the topography and clutter of the surroundings of the radio observatory. In contrast, interference by satellite transmitters is likely to be received via the main beam and inner side lobes, with considerably higher gain. Because interference from terrestrial transmitters to RAS receivers is almost always received through the antenna side lobes, the main beam response to interference need not be considered.

Finally, because RAS operates at known fixed remote locations, and in order to avoid restrictive unwanted emission limits, the Commission could establish exclusion or coordination zones to avoid interference to those RAS locations. Since these are remote sites, exclusion or coordination zones will not likely impact wireless industry efforts to reach most of the U.S. population.

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with Regard to Commercial Operations in the 3550-3650 MHz Band, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd. 3959 (2015). Similarly, in the AWS-3 proceeding, the Commission made 40 megahertz available for commercial use pursuant to collaboration between commercial and federal users. *See Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695- 1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands*, Report and Order, 29 FCC Rcd. 4610 (2014).

43/ T-Mobile has attached copies of those Recommendations as **Appendix B** to these comments.

44/ *See* RECOMMENDATION ITU-R RA.517-4: PROTECTION OF THE RADIO ASTRONOMY SERVICE FROM TRANSMITTERS OPERATING IN ADJACENT BANDS, INTERNATIONAL TELECOMMUNICATION UNION, at 3 (2006); *see also* REPORT ITU-R SM.2092: STUDIES RELATED TO THE IMPACT OF ACTIVE SERVICES ALLOCATED IN ADJACENT OR NEARBY BANDS ON EARTH EXPLORATION-SATELLITE SERVICE (PASSIVE), INTERNATIONAL TELECOMMUNICATION UNION, at 12-13 (2007).

The Band Should Not Be Restricted to Fixed Use. While the Fixed Wireless Communications Coalition has requested that the band be designated for fixed operations, the better approach is to adopt rules that will permit any technically feasible terrestrial operations. Licensees can decide if the best use of the band is for mobile or fixed use, or a combination of the two, and a single licensee will be able to coordinate different band uses in its licensed geographic area.

Band Plan/Block Size. Because of the limited amount of spectrum in the band and in order to promote competition, the Commission should depart from 200 megahertz channel sizes here and license the band in five 100 megahertz blocks. Alternatively, the band could be considered in conjunction with the adjacent 40-42 GHz band as discussed above[45/] and licensed in 200 megahertz blocks consistent with the 37-40 GHz band.

T-Mobile strongly opposes the Commission's proposal to add federal fixed and mobile allocations into this band.[46/] Such an approach would unnecessarily limit necessary commercial access to this band. Moreover, and as noted above, creating new federal allocations where there are none today – as opposed to preserving sharing where federal use is already permitted – would be contrary to the stated goals of Congress, which has taken action to encourage federal users to vacate spectrum in order to make more spectrum available for commercial use.[47/]

47 GHz Band (47.2-50.2 GHz). There are presently non-federal fixed and mobile allocations in the 47 GHz band, but there are no corresponding service rules. Specifically, the

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45/ *See* discussion above, pages 4-5.

46/ *See FNPRM*, ¶ 407.

47/ *See* Middle Class Tax Relief and Job Creation Act of 2012, Public Law 112–96, 126 Stat. 156 (2012) (requiring that NTIA give priority to reallocation options that assign spectrum for exclusive, non-federal use over options that involve sharing when transitioning spectrum from federal to commercial use).

Commission has designated 47.2-48.2 GHz for wireless service use and 48.2-50.2 GHz for fixed satellite use, and the fixed allocations at 47.2-47.5 GHz and 47.9-48.2 GHz are designated for high altitude platform service. In addition, the entire band has an earth-to-space satellite allocation, for which there are service rules, and the 47.2-49.2 GHz band is available for BSS feeder links. There is a federal allocation for fixed, mobile, and earth-to-space satellite operations at 48.2-50.2 GHz, and the 48.94-49.04 GHz band is also used by radio astronomy.[48/]

Band Plan/Block Size. T-Mobile supports the Commission's proposal to authorize fixed and mobile operations in the 47 GHz band under the Part 30 rules.[49/] The Commission does not propose a band plan for the 47 GHz band, but it should license this spectrum in 200 megahertz wide channels consistent with the 37 and 39 GHz bands.[50/] To protect radio astronomy in the 48.94-49.04 GHz band, exclusion or coordination zones could be established to prevent interference to RAS from terrestrial services.

Protection of EESS. The Commission also asks about requirements that would be appropriate to protect passive services (EESS) from fixed and mobile use in the 50.2-50.4 GHz band.[51/] The nature and technology of 5G deployments is still uncertain, and the Commission should not take any action now that would limit future terrestrial use of this band. Rather, it should encourage further study and coordination between EESS users and fixed and mobile users so that appropriate protections, if any, may be determined as the technology develops.

FSS Sharing. The Commission should not adopt rules providing for (i) a terrestrial mobile and FSS earth station sharing framework like the one adopted for the 28 GHz band; or

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48/ *See FNPRM*, ¶ 408.

49/ *See FNPRM*, ¶ 410.

50/ *See FNPRM*, ¶ 417.

51/ *See FNPRM*, ¶ 416.

(ii) an SAS to facilitate sharing between terrestrial operations and FSS user equipment, both of which it suggests as options for sharing between FSS and terrestrial operations.[52/] The Commission adopted a sharing framework in the 28 GHz band because of incumbent users there. However, there are no currently authorized FSS operations in the 47 GHz band,[53/] and none are expected. The Commission also should not employ an SAS approach to sharing for FSS user equipment. As T-Mobile notes elsewhere, the SAS approach is unnecessarily complex and untested, particularly with respect to use among different services. Moreover, as the Commission recognizes, "sharing between terrestrial mobile and FSS user equipment is more complicated particularly when the FSS user equipment is transmitting"[54/] thus making it even less suitable for sharing through an untested SAS-based approach.

If, however, the Commission chooses to permit FSS operations in the band, it should adopt the proposed option to divide the band into a segment where FSS has priority and a segment where UMFUS operations have priority.[55/] That segmentation should approximate the division the Commission created in the 37-40 GHz band for licensed and other uses. This split would help ensure that sufficient spectrum is allocated to commercial mobile use to meet consumer demand, and would do no harm to (currently non-existent) FSS operations.

Federal/Non-Federal Sharing. As with the 42 GHz band, T-Mobile opposes sharing between federal and non-federal users in the 48.2-50.2 GHz band. There are currently no federal

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52/ *See FNPRM*, ¶¶ 412-13.

53/ *See FNPRM*, ¶ 411.

54/ *FNPRM*, ¶ 411.

55/ *See FNPRM*, ¶ 414.

operations in this band[56/] – providing federal operations co-primary status in a band they have not put to use would be contrary to Congress's goals.

50 GHz Band (50.4-52.6 GHz). As with the 42 and 47 GHz bands, the 50 GHz band has primary fixed and mobile allocations (throughout the band in this case), but no service rules. There are also primary non-federal and federal allocations in the band at 50.4-51.4 GHz for earth-to-space satellite and mobile satellite, and this segment has been designated for wireless services.[57/]

Band Plan/Block Size/Sharing. T-Mobile supports the Commission's proposal to authorize fixed and mobile operations in the 50 GHz band under the Part 30 rules,[58/] and supports licensing in 200 megahertz wide channels consistent with the 37 and 39 GHz bands.[59/] As with other bands that have co-channel and adjacent channel federal operations, T-Mobile is confident that protection of federal incumbent users is feasible through CSMAC-evaluated mechanisms. However, T-Mobile opposes database-driven sharing and a first-come, first-served approach.[60/] Instead, the Commission should designate the band exclusively for non-federal use, with protection of federal incumbents.

Protection of Passive Band Services. The Commission asks whether there is a need to establish a guard band immediately below 52.6 GHz to protect the passive band above 52.6

56/ *See FNPRM*, ¶ 416.

57/ *See FNPRM*, ¶ 418.

58/ *See FNPRM*, ¶ 420. In fact, as the Commission notes in the *FNPRM*, even though this band was not addressed in the *Notice of Proposed Rulemaking* in this proceeding, T-Mobile has previously supported further consideration of this band. *Id.*, ¶ 419.

59/ *See FNPRM*, ¶ 423.

60/ *See FNPRM*, ¶ 422 (discussing as possibilities database-driven sharing and a first-come, first-served approach).

GHz.[61/] A guard band may not be necessary, as the nature and technology of 5G deployments may limit emissions, including aggregate emissions transmitted toward the sensing satellites.

70/80 GHz Bands (71-76 GHz and 81-86 GHz). In 2003, the Commission set rules for the 70/80 GHz bands using a two-pronged authorization scheme in which licensees apply for nationwide non-exclusive licenses and then register individual point-to-point links.[62/] Currently, there are 446 active licenses and 22,600 links registered. Access to the bands is based on sharing mechanisms with federal users. Specifically, the 71-74 GHz band has federal and non-federal fixed, mobile, FSS, and mobile satellite allocations. The 74-76 GHz band has federal and non-federal fixed, space-to-earth satellite, mobile and Space Research Service allocations. The 81-86 GHz band has allocations for federal and non-federal fixed, earth-to-space satellite and mobile, and the sub-band 81-84 GHz has an earth-to-space mobile satellite allocation. The 71-76 GHz band is currently used for unlicensed vehicular radar and the Commission has proposed to authorize non-federal radar applications in the 76-81 GHz band.[63/]

The Commission Should Reject a SAS Approach. The Commission proposes establishment of an SAS-based framework for the 70/80 GHz bands under either the Part 96 Citizens Broadband Radio Service rules or the new Part 30 UMFUS rules. Under this framework, there would be three tiers of users, from highest to lowest level of protection: (1) Incumbent Access users; (2) Priority Access Licensees ("PALs"); and (3) General Authorized Access ("GAA") users.[64/] T-Mobile strongly opposes this approach. It continues to question the

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61/ *See FNPRM*, ¶ 423.

62/ *See Allocations and Service Rules for the 71-76 GHz, 81-86 GHz, and 92-95 GHz Bands*, Report and Order, 18 FCC Rcd. 23318 (2003); *FNPRM*, ¶ 424.

63/ *See FNPRM*, ¶¶ 424-27.

64/ *See FNPRM*, ¶ 440.

efficacy of an SAS system, which remains completely untested in real-world environments. Accordingly, the Commission should refrain from applying this framework to additional bands. Instead, the Commission should adopt exclusive geographic licensing and require that new licensees coordinate with incumbent federal and non-federal users.[65/] Such coordination can be easily accomplished because the fixed operations at 70/80 GHz are highly directionalized, "pencil-beam" operations.

As noted above, exclusive licensing encourages greater investment and innovation by providing carriers with much needed certainty. Moreover, as the Commission acknowledges, the traditional coordination process between federal and non-federal users in this band "has been effectively used for over a decade to facilitate coexistence between commercial systems and Federal systems[.]"[66/] Federal and non-federal incumbent users should be grandfathered during a specified transition period, with geographic area licensees using current coordination methodologies, after which non-federal incumbent users would either need to obtain licenses through auction or secondary markets or seek agreements with licensees to remain protected. Incumbent federal users would continue to be protected unless they could be relocated through the Commercial Spectrum Enhancement Act process.

III. SHARING IN THE 37 GHZ BAND (37-38.6 GHz) MUST MAXIMIZE LICENSED USE AND DEPLOY MANUAL COORDINATION

In the *Report and Order*, the Commission divided the 37 GHz band into two segments – a lower band segment from 37-37.6 GHz and an upper band segment from 37.6-38.6 GHz – and

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65/ Non-federal licensees would have the opportunity to secure geographic area licenses in an auction or in the secondary market to ensure continued primary protection.

66/ *FNPRM*, ¶ 439.

set different licensing rules for each segment.[67/] The lower band segment will be available on a shared basis between federal and non-federal users, while the upper band will be licensed and auctioned in 200 megahertz blocks.[68/] The *FNPRM* seeks comment on sharing issues in each segment.

Lower Band Segment (37-37.6 GHz). The *FNPRM* asks whether the Commission should rely in the lower band segment on "manual frequency coordination, a dynamic SAS-type mechanism, or something in between."[69/] In implementing sharing, the Commission should reject proposals that rely on the untested SAS mechanism. Moreover, there are no identified federal use cases for the band; selecting a particular sharing mechanism – especially one as untested as an SAS – is premature.

Sharing Mechanisms. The Commission should allow industry to develop mechanisms for sharing within the 37-37.6 GHz band based on the use cases that stakeholders expect to be developed. The Commission took a similar approach with unlicensed access to the 3.5 GHz band, and the Wireless Innovation Forum is currently developing access mechanisms for that band.[70/] Similar efforts are underway by 3rd Generation Partnership Project ("3GPP") to

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67/ *See Report and Order*, ¶¶ 106-118.

68/ *See Report and Order*, ¶¶ 106-118.

69/ *FNPRM*, ¶ 450.

70/ *See Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band,* Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd. 3959, ¶ 319 (2015); Wireless Innovation Forum *Ex Parte,* GN Dkt. No. 12-354 (filed Apr. 22, 2016) (discussing activities undertaken by the Wireless Innovation Forum to support the development and advancement of spectrum sharing technologies for the 3.5 GHz band), Wireless Innovation Forum *Ex Parte,* GN Dkt. No. 12-354 (filed Feb. 18, 2016) (same as above).

determine how shared spectrum can be used with Licensed Assisted Access ("LAA") techniques.[71/]

Federal users should be encouraged to take advantage of the sharing mechanisms that industry develops. If federal users are unable to adopt that approach, there should be a manual, direct coordination framework for federal and non-federal users in the band. This type of coordination framework is consistent with past Commission practice for incumbent operations and has proven successful in other bands.[72/] Standard frequency coordination practices should be employed to accommodate any future federal uses of the band.

Adopting an industry-based coordination framework would also resolve issues related to authorization expiration and construction requirements more easily than the Commission's proposal. The proposed requirement that registered non-federal sites be put into service within seven days of coordination and that registered and coordinated sites reassert their registration every seven days[73/] is unrealistic and inconsistent with almost all other types of Commission authorizations. The Commission should permit implementation and license retention more typical of other wireless services. If the Commission wishes to permit more dynamic use of this band, it can allow users to agree on construction and check-in requirements as part of the coordination process.

71/ *LAA standardization: coexistence is the key*, 3GPP (July 13, 2016), http://www.3gpp.org/news-events/3gpp-news/1789-laa_update.

72/ For instance, in the AWS-3 proceeding, the Commission made 40 megahertz available for commercial use pursuant to static, manual collaboration between commercial and federal users. *See Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695- 1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands*, Report and Order, 29 FCC Rcd. 4610 (2014). While further operations in the AWS-3 band were not permitted, the collaboration at least address incumbent operations.

73/ *See FNPRM*, ¶ 456.

No Additional Interference Mitigation Necessary. The Commission further states that there may be users "for which any interference may be significantly problematic" and seeks comment on additional interference mitigation and enforcement mechanisms.[74/] Contrary to the Commission's suggestion,[75/] no additional enforcement mechanisms are necessary. Federal and non-federal licensees share spectrum successfully today without special enforcement measures. The Commission has adequate enforcement mechanisms in place to help identify and rectify interference events, and no additional measures are necessary.

Priority Access for Federal Users. The Commission asks whether it should make a portion of the lower band segment available for priority access by federal users.[76/] T-Mobile questions whether priority for federal users is appropriate based on Congressional directive or is even necessary. Instead, both federal and non-federal users should employ industry-developed coordination mechanisms. Nevertheless, should the Commission decide to grant priority access to federal users,[77/] it should do so only in a limited portion of the lower band segment in order to ensure reliable access to the spectrum by non-federal users. Any such priority access should be granted via static reservation and not via dynamic re-assignment, the latter of which would result in an unpredictable environment damaging to commercial use.

Minimum Channel Size. T-Mobile supports the Commission's proposal to establish a 100 megahertz minimum channel size for the band.[78/] A guaranteed minimum channel size designed to satisfy high-bandwidth demands will help create a market for equipment in the band. T-

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74/ *See FNPRM*, ¶ 458.

75/ *See FNPRM*, ¶ 458

76/ *See FNPRM*, ¶ 457.

77/ *See FNPRM*, ¶ 457.

78/ *See FNPRM*, ¶ 454.

Mobile also supports the proposal to allow users to aggregate 100 megahertz channels into larger channel sizes up to the maximum of 600 megahertz.[79/]

Upper Band Segment (37.6-38.6 GHz).

Use-it-or-Share-It. The Commission proposes to permit shared access of the unused portions of the upper band segment on a use-it-or-share-it basis.[80/] The Commission should not adopt this approach for the upper band segment of the band (or any other band available for commercial operations). Although the Commission states that, under its proposal, licensees would retain primary rights to the spectrum and that "any operations undertaken on a shared basis would be subject to displacement by the primary licensee[,]"[81/] that assessment is without precedent and unrealistic. The Commission asserts that it has "found spectrum sharing to be an efficient tool to maximize spectrum efficiency,"[82/] but it provides no evidence that a use-it-or-share-it approach is a successful form of spectrum sharing. To the contrary, the Commission's proposal introduces uncertainty, undermining the viability of the band for commercial operations. It is questionable as to whether licensees will actually be able to displace sharers when they wish to use spectrum that they acquired at auction. Moreover, requiring licensees to provide information about system operations,[83/] which is a necessary prerequisite to sharing, is contrary to the nature of geographic area licensing and may impede licensees' ability to dynamically reconfigure their networks. Adopting a use-it-or-share-it approach would therefore hamstring licensees, create greater uncertainty, and harm the Commission's efforts to maximize

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79/ *FNPRM*, ¶ 454.

80/ *FNPRM*, ¶ 460.

81/ *FNPRM*, ¶ 462.

82/ *FNPRM*, ¶ 461.

83/ *See FNPRM*, ¶ 462.

spectrum efficiency. The Commission should instead promote efficient spectrum use through the practices that have led to today's robust mobile environment – performance requirements and rules allowing partitioning, disaggregation, and leasing. Federal access to the upper segment of the 37 GHz band should similarly be secured through voluntary arrangements between licensees and federal users.

Keep What You Use. T-Mobile similarly opposes the option that licensees "keep-what-they-use" at the end of the license term.[84/] The proposal is based on the false presumption that merely because a licensee has not covered an area within its license term it never will. To the contrary, there may be legitimate reasons why a particular area is not covered – *e.g.* siting challenges, backhaul issues, or lack of current demand. However, licensees may have long-term plans to serve areas not covered at the end of a license term. If they do not, licensees can take advantage of leasing, disaggregation or partitioning mechanisms. Consumers have a better chance to receive service from an entity that would merely extend existing coverage than a licensee with no coverage at all. Accordingly, licensees should be able to retain their entire licensed areas when they meet performance requirements at the end of a license term.

IV. LICENSING, OPERATING, REGULATORY AND TECHNICAL ISSUES FOR LICENSED MILLIMETER WAVE SPECTRUM

The Commission seeks further comment on various licensing, operating, regulatory, and technical rules for UMFUS operations. Most notably, the Commission should not adopt further performance requirements at this time or, as noted above, any use-it-or-share-it approach for UMFUS licenses, and it should take steps to ensure that no single carrier is able to dominate portions of the millimeter wave spectrum.

84/ *See FNPRM*, ¶¶ 460-61.

Performance Metrics. Despite the advances in millimeter wave technology, it remains unclear how the bands will develop, and therefore it is premature for the Commission to attempt to adopt additional rules or benchmarks seeking to cover every possible application.[85/] Rather, the Commission should, except as specified in the *Report and Order's* safe harbors for fixed and mobile use, allow licensees greater flexibility and review deployment on a case-by-case basis. It may be appropriate, as technologies develop and performance deadlines draw nearer, for the Commission to create additional safe harbors based on developing use cases, but taking that step now is unnecessary.

Sharing Mechanisms. The Commission seeks comment on whether to implement a use-or-share regime in all UMFUS bands.[86/] As noted above, T-Mobile strongly opposes adoption of a use-it-or-share-it approach in the upper segment of the 37 GHz band. It similarly opposes this approach in any of the UMFUS bands[87/] for the same reasons: (i) it is unlikely that licensees will actually be able to displace sharers when they wish to use their licensed spectrum; (ii) the approach will create greater uncertainty; and (iii) the approach may inhibit licensees' ability to dynamically reconfigure their networks. Accordingly, the Commission should not adopt <u>any</u> of the flawed use-it-or-share-it or "keep-what-you-use" proposals in the *FNPRM*.[88/]

Mobile Spectrum Holdings Policies.

Assessing Bidding Eligibility. The Commission seeks comment on two alternative methodologies for assessing bidding eligibility: (i) the "maximum county-to-PEA" approach,

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85/ *See FNPRM*, ¶¶ 465-72 (seeking comment on additional performance metrics and possible benchmarks).

86/ *See FNPRM*, ¶ 474.

87/ *See FNPRM*, ¶ 474 (seeking further comment on the possibility of implementing of a use-it-or-share-it regime in the UMFUS bands).

88/ *See FNPRM*, ¶¶ 477-80.

under which the highest level of spectrum holdings of a county in a PEA would be imputed to the entire PEA; and (ii) the "population-weighted-average" approach, under which the product of county spectrum holdings and county population would be summed and then divided by the PEA population.[89/] The Commission should adopt the proposed "population-weighted-average" approach – the same approach used for the Incentive Auction – as it produces a fairer outcome overall, even if it results in higher holdings calculations in some counties. The differences in spectrum holdings across counties are not likely to be significant enough to merit prohibiting spectrum acquisition in some counties that exceed the average.

Holding Periods. The Commission proposes to establish a three year holding period.[90/] T-Mobile agreed with the Commission when it established a market-based spectrum reserve in the 600 MHz band.[91/] A holding period in that band made sense in order to ensure the spectrum reserve operates effectively. However, the Commission has not proposed a spectrum reserve in the millimeter wave bands. Accordingly, a holding period for transactions in these bands is unnecessary. Instead, a holding period would counter-productively prevent new entrants from securing spectrum and prevent existing licensees from securing needed additional capacity or merely rationalizing spectrum holdings with other licensees. A holding period is also more likely to contribute to spectrum warehousing than result in any pro-competitive outcome. Instead, meaningful enforcement of spectrum aggregation limits; partitioning, disaggregation and leasing rules; and performance requirements will help to prevent gamesmanship in auctions and the secondary market. Nevertheless, T-Mobile agrees that the Commission must prevent

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89/ *See FNPRM*, ¶¶ 486-87.

90/ *See FNPRM*, ¶ 488.

91/ *See Policies Regarding Mobile Spectrum Holdings*, Report and Order, 29 FCC Rcd. 6133 (2014).

trafficking in spectrum licenses, particularly by entities that take advantage of Designated Entity ("DE") benefits. Accordingly, in addition to the other restrictions on DE licenses, it should impose the holding period proposed in the *FNPRM* on those entities.

Mobile Spectrum Holding Limits. The Commission should impose a one-third limit across any additional bands allocated through the *FNPRM*.[92/] In addition, it should re-evaluate imposing in-band limits. As T-Mobile detailed previously,[93/] a single screen suggests millimeter wave spectrum is fungible. But this assumption may not be true – particularly as the Commission makes additional bands available from 24 GHz to above 90 GHz – and it is not clear how technical differences will affect providers' ability to satisfy different use cases. In addition to technical differences, bands may have different rules governing sharing and other potential limitations. It is therefore not reasonable to assume that access to a particular millimeter wave band will be a substitute for access to all millimeter wave bands. Ensuring diversity of ownership in a band will facilitate competition and a healthy device ecosystem, and a screen helps ensure that the competitive impacts of a transaction can be properly and fully evaluated under the totality of circumstances, including the substitutability of available millimeter wave bands.

37.5-40 GHz Band Satellite Technical Issues. The Commission seeks comment on whether there are circumstances under which allowing FSS satellites in the 37.5-40 GHz band to operate at a higher PFD level than currently permitted would be consistent with terrestrial use of

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92/ *See FNPRM*, ¶ 491. The *Report and Order* asserts that the 1250 megahertz limit the Commission imposed is one-third of the available spectrum in the millimeter wave bands. It is not, for the reasons noted above regarding the availability of spectrum for licensed, commercial operations. While the Commission should adhere to the one-third limit, it should revise the spectrum included in its evaluation.

93/ *See* T-Mobile *Ex Parte*, GN Docket No. 14-177, at 6 (filed June 30, 2016).

the 37.5-40 GHz band.[94/] T-Mobile strongly opposes any increase in satellite PFD limits in the 37.5-40 GHz band. Particularly at 37.6-38.6 GHz, where there are no current non-federal operations, the band is ideally suited to support new 5G entrants. Their success should not be potentially compromised by inconsistent satellite operations. The Commission correctly recognizes that "the burden is on FSS interests to show that the higher PFD level is consistent with terrestrial use[,]"[95/] a showing that they have not and are not able to make.

Boeing Analysis. The Commission cites technical analysis presented by Boeing in the earlier phase of this proceeding.[96/] The Boeing analysis is flawed. It predicts an interference-to-noise ("I/N") ratio of -14.3 dB. This was based on 5G base stations having at least 20 dB of isolation from satellite downlink transmissions. This level of isolation requires that the base station antenna would not point at elevation angles above the horizon. However, it is possible that the base station antenna may steer to higher elevation angles to find stronger non-line-of-sight ("NLOS") paths to users, such as diffraction paths along buildings.

Boeing also asserted that if base station transmitters point upward, buildings would shield the base stations from line-of-sight ("LOS") events with the satellites.[97/] This may be true for dense city centers with tall buildings. However, for rural scenarios or suburban scenarios with smaller buildings, this may not be the case. Boeing proposed a large constellation of satellites, increasing the probability of upward pointing base stations aiming toward a satellite. The satellite was assumed to be at an elevation angle greater than 45 degrees. Since the proposed

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94/ *FNPRM*, ¶ 499.

95/ *FNPRM*, ¶ 499.

96/ *FNPRM*, ¶ 498.

97/ Letter from Bruce Olcott, Counsel to The Boeing Company, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177 (July 7, 2016).

Boeing satellite system is an NGSO system, satellites could be at much lower elevation angles. T-Mobile is not aware of any restrictions on the pointing angles of earth stations for the proposed Boeing system. Therefore, the 20 dB isolation may not be a reliable assumption. If the isolation is reduced to 10 dB, the resultant I/N would be -4.3 dB, which is a significant level of interference.

Authorizing Satellite User Equipment. The Commission seeks comment on the possibility of repealing the prohibition on satellite user equipment in the 37.5-40 GHz band.[98/] T-Mobile opposes such a repeal. Deploying ubiquitous satellite user equipment means that the satellite beams would need to provide coverage wherever the user terminals are located, which would result in unpredictable interference to 5G base stations and mobile receivers.

Digital Station Identification. The Commission asks whether it should require transmission of digital identification ("digital ID") by millimeter wave band systems, as it does for AM/FM/TV broadcasters.[99/] While T-Mobile appreciates the Commission's goal of more swiftly locating sources of interference, requiring digital ID will not advance it. Digital ID is already transmitted by terrestrial mobile operations today and can be identified by all carriers. Moreover, imposition of a particular ID format will lock in place technology, potentially limiting migration to advanced or alternative transmission techniques adopted for use in the millimeter wave bands. Transmission of a digital ID is especially unnecessary for licensees authorized on a geographic area basis, as there will only be one licensee per geographical area using the relevant millimeter wave spectrum, and the Commission or other licensees may be able to learn from the Commission's licensing database the identity of the spectrum user in a particular area.

98/ *See FNPRM*, ¶ 501.

99/ *See FNPRM*, ¶ 503.

Antenna Height. Because it received little comment on this issue previously, the Commission again seeks comment on whether it should adopt the power limits and antenna heights provided for in Part 27 for PCS and AWS.[100/] T-Mobile continues to support adoption of these limits, as consistent rules across mobile terrestrial services will aid deployment.[101/]

Minimum Bandwidth for Give BS/MS/Transportable Transmit Power Levels. In the *Report and Order*, the Commission adopted a rule for the base station power limits that scales the maximum power over a 100 megahertz bandwidth. It now asks whether it should consider a sub-set of networks that might operate with bandwidths less than 100 megahertz.[102/] As the Commission suggests, it is conceivable that some parts of future 5G networks will require less than 100 megahertz bandwidth. To maintain uniform power flux density (dBm/Hz) across the entire network and avoid potential inconsistencies and interference among different parts of the network, a power scaling factor equal to the ratio of the bandwidth to 100 megahertz can be adopted. To avoid hampering future developments, the Commission should not specify a minimum bandwidth for base stations, transportable devices, and mobile devices and should just require scaling down of their power according to the ratio of used bandwidth to 100 megahertz.

Coordination Criteria at Market Borders for Fixed Point to Point Operations. The Commission states that it believes changes to market sizes provided for in the *Report and Order* "warrant[] re-examination of the market boundary coordination requirements that were originally developed in the context of larger market sizes" and seeks comment on appropriate coordination

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100/ *See FNPRM*, ¶¶ 505-06.

101/ *See* T-Mobile Comments at 20.

102/ *See FNPRM*, ¶¶ 507-08.

criteria.[103/] The Commission should retain the existing Part 101 coordination requirements for traditional fixed point-to-point deployments, under which fixed point-to-point operations within 16 kilometers (in the 38.6-40 GHz band) or 20 kilometers (in the 27.5-28.35 GHz band) of a licensee's market boundary must coordinate with co-channel licensees in adjacent market areas.[104/] Existing rules have generally been effective and should protect adjacent area mobile, as well as fixed, operations.

Sharing Analysis and Modeling. As the Commission notes, industry, standards groups, government organizations, and academia are working together to develop propagation models for millimeter wave bands – for example, the National Institute of Standards and Technology ("NIST") and the European Commission both have study groups looking at this issue.[105/] T-Mobile generally supports use of modeling by third parties such as NIST and the European Commission as part of the effort to establish neutral criteria for analyzing inter-service interference between terrestrial-based transmitters and receivers of different services. Nevertheless, T-Mobile opposes substantial sharing between satellite and terrestrial operations – there has been no demonstration that both uses can occur simultaneously. As also noted above, however, fixed and mobile authorizations are likely to be held by the same licensee, who can self-coordinate.

V. CONCLUSION

T-Mobile greatly appreciates the Commission's efforts to make additional spectrum available for licensed mobile use. In order to make full mobile use of the millimeter wave bands

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103/ *See FNPRM*, ¶ 5010.

104/ *See FNPRM*, ¶ 509.

105/ *See FNPRM*, ¶ 512.

and to encourage the greatest amount of investment and innovation, the Commission should take the following actions:

- make more spectrum available for licensed operations including bands not specifically mentioned in the *FNPRM*;
- exclusively license all proposed bands on a PEA-basis;
- issue licenses covering 200 megahertz blocks except where smaller sizes are necessary to promote competition;
- reject use of untested sharing approaches such an SAS or use-it-or-share-it in *any* UMFUS bands;
- limit federal/non-federal sharing, except where necessary to preserve existing operations or where there is no impact on commercial operations, and rely on traditional manual coordination for sharing;
- refrain from adopting additional performance metrics;
- adopt the "population-weighted-average" approach to spectrum holdings assessments in an auction, impose a one-third limit on spectrum aggregation across the bands allocated through the *FNPRM*, and reconsider imposing in-band limits;
- reject proposals to increase satellite PFD limits in the 37.5-40 GHz band and maintain the prohibition on satellite user equipment in this band;
- refrain from adopting digital ID requirements;
- adopt power limits and antenna heights consistent with Part 27 for PCS and AWS;
- retain the existing Part 101 coordination requirements for traditional fixed point-to-point deployments; and
- support efforts to develop propagation models by third parties such as NIST and the European Commission while generally rejecting satellite/terrestrial sharing.

Respectfully submitted,

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APPENDIX A

Table of Allocations Footnotes Concerning Radio Astronomy Locations

US74 In the bands 25.55-25.67, 73-74.6, 406.1-410, 608-614, 1400-1427, 1660.5-1670, 2690-2700, and 4990- 5000 MHz, and in the bands 10.68-10.7, 15.35-15.4, 23.6-24.0, 31.3-31.5, 86-92, 100-102, 109.5-111.8, 114.25- 116, 148.5-151.5, 164-167, 200-209, and 250-252 GHz, the Radio Astronomy service shall be protected from unwanted emissions only to the extent that such radiation exceeds the level which would be present if the offending station were operating in compliance with the technical standards or criteria applicable to the service in which it operates. Radio astronomy observations in these bands are performed at the locations listed in US385.

US385 Radio astronomy observations may be made in the bands 1350-1400 MHz, 1718.8-1722.2 MHz, and 4950-4990 MHz on an unprotected basis, and in the band 2655-2690 MHz on a secondary basis, at the following Radio Astronomy observatories:

Location	Geographical Area
Hat Creek, CA	Rectangle between latitudes 40° 00' N and 42° 00' N and between longitudes 120° 15' W and 122° 15' W
Goldstone, CA	80 kilometer radius centered on 35° 20' N, 116° 53' W
Arecibo, PR	Rectangle between latitudes 17° 30' N and 19° 00' N and between longitudes 65° 10' W and 68° 00' W
Socorro, NM	Rectangle between latitudes 32° 30' N and 35° 30' N and between longitudes 106° 00' W and 109° 00' W
Green Bank, WV	Rectangle between latitudes 37° 30' N and 39° 15' N and between longitudes 78° 30' W and 80° 30' W
Brewster, WA	80 kilometer radius centered on 48° 08' N, 119° 41' W
Fort Davis, TX	80 kilometer radius centered on 30° 38' N, 103° 57' W
Hancock, NH	80 kilometer radius centered on 42° 56' N, 71° 59' W
Kitts Peak, AZ	80 kilometer radius centered on 31° 57' N, 111° 37' W
Los Alamos, NM	80 kilometer radius centered on 35° 47' N, 106° 15' W
Mauna Kea, HI	80 kilometer radius centered on 19° 48' N, 155° 27' W
North Liberty, IA	80 kilometer radius centered on 41° 46' N, 91° 34' W
Owens Valley, CA	80 kilometer radius centered on 37° 14' N, 118° 17' W
Pie Town, NM	80 kilometer radius centered on 34° 18' N, 108° 07' W
Saint Croix, VI	80 kilometer radius centered on 17° 45' N, 64° 35' W
Big Pine, CA	Two contiguous rectangles, one between latitudes 36° 00' N and 37° 00' N and between longitudes 117° 40' W and 118° 30' W and the second

	between latitudes 37° 00' N and 38° 00' N and between longitudes 118° 00' W and 118° 50' W

(a) In the bands 1350 -1400 MHz and 4950-4990 MHz, every practicable effort will be made to avoid the assignment of frequencies to stations in the Fixed and Mobile Services that could interfere with Radio Astronomy observations within the geographic areas given above. In addition, every practicable effort will be made to avoid assignment of frequencies in these bands to stations in the aeronautical Mobile Service which operate outside of those geographic areas, but which may cause harmful interference to the listed observatories. Should such assignments result in harmful interference to these observatories, the situation will be remedied to the extent practicable.

(b) In the band 2655-2690 MHz, for Radio Astronomy observations performed at the locations listed above, licensees are urged to coordinate their systems through the Electromagnetic Spectrum Management Unit, Division of Astronomical Sciences, National Science Foundation, Room 1030, 4201 Wilson Blvd., Arlington, VA 22230.

APPENDIX B

International Telecommunication Union Recommendations for Protecting RAS Operations from Terrestrial Operations

Table 1. Threshold levels of interference detrimental to Radio Astronomy continuum observations

Centre frequency [1] f_c, MHz	Assumed bandwidth Δf, MHz	Minimum antenna noise temperature T_A, K	Receiver noise temperature T_R, K	System sensitivity [2] (noise fluctuations)		Threshold interference levels [2] [3]		
				Temperature ΔT, mK	Power spectral density ΔP, dB(W/Hz)	Input power P_H, dBW	pfd $S_H \Delta f$, dB(W/m^2)	Spectral pfd S_H, dB(W/(m^2 · Hz))
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
13.385	0.05	50 000	60	5 000	–222	–185	–201	–248
25.610	0.12	15 000	60	972	–229	–188	–199	–249
73.8	1.6	750	60	14.3	–247	–195	–196	–258
151.525	2.95	150	60	2.73	–254	–199	–194	–259
325.3	6.6	40	60	0.87	–259	–201	–189	–258
408.05	3.9	25	60	0.96	–259	–203	–189	–255
611	6.0	20	60	0.73	–260	–202	–185	–253
1 413.5	27	12	10	0.095	–269	–205	–180	–255
1 665	10	12	10	0.16	–267	–207	–181	–251
2 695	10	12	10	0.16	–267	–207	–177	–247
4 995	10	12	10	0.16	–267	–207	–171	–241
10 650	100	12	10	0.049	–272	–202	–160	–240
15 375	50	15	15	0.095	–269	–202	–156	–233
22 355	290	35	30	0.085	–269	–195	–146	–231
23 800	400	15	30	0.050	–271	–195	–147	–233
31 550	500	18	65	0.083	–269	–192	–141	–228
43 000	1 000	25	65	0.064	–271	–191	–137	–227
89 000	8 000	12	30	0.011	–278	–189	–129	–228
150 000	8 000	14	30	0.011	–278	–189	–124	–223
224 000	8 000	20	43	0.016	–277	–188	–119	–218
270 000	8 000	25	50	0.019	–276	–187	–117	–216

Note:

(1) Calculation of interference levels is based on the centre frequency shown in this column although not all regions have the same allocations.

(2) An integration time of 2 000 s has been assumed; if integration times of 15 min, 1 h, 2 h, 5 h or 10 h are used, the relevant values in the Table should be adjusted by +1.7, -1.3, -2.8, -4.8 or -6.3 dB, respectively.

(3) The interference levels given are those which apply for measurements of the total power received by a single antenna. Less stringent levels may be appropriate for other types of measurements, as discussed in § 2.2. For transmitters in the GSO, it is desirable that the levels be adjusted by -15 dB, as explained in § 2.1.

Table 2. Threshold levels of interference detrimental to Radio Astronomy spectral-line observations

Frequency f_c, MHz	Assumed spectral line channel bandwidth Δf, kHz	Minimum antenna noise temperature T_A, K	Receiver noise temperature T_R, K	System sensitivity[2] (noise fluctuations)		Threshold interference levels[1] [2]		
				Temperature ΔT, mK	Power spectral density ΔP_S, dB(W/Hz)	Input power ΔP_H dBW	pfd $S_H \Delta f$, dB(W/m^2)	Spectral pfd S_H dB(W/(m^2 · Hz))
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
327	10	40	60	22.3	–245	–215	–204	–244
1 420	20	12	10	3.48	–253	–220	–196	–239
1 612	20	12	10	3.48	–253	–220	–194	–238
1 665	20	12	10	3.48	–253	–220	–194	–237
4 830	50	12	10	2.20	–255	–218	–183	–230
14 488	150	15	15	1.73	–256	–214	–169	–221
22 200	250	35	30	2.91	–254	–210	–162	–216
23 700	250	35	30	2.91	–254	–210	–161	–215
43 000	500	25	65	2.84	–254	–207	–153	–210
48 000	500	30	65	3.00	–254	–207	–152	–209
88 600	1 000	12	30	0.94	–259	–209	–148	–208
150 000	1 000	14	30	0.98	–259	–209	–144	–204
220 000	1 000	20	43	1.41	–257	–207	–139	–199
265 000	1 000	25	50	1.68	–256	–206	–137	–197

Note:

* This Table is not intended to give a complete list of spectral-line bands, but only representative examples throughout the spectrum.

(1) An integration time of 2 000 s has been assumed; if integration times of 15 min, 1 h, 2 h, 5 h or 10 h are used, the relevant values in the Table should be adjusted by +1.7, -1.3, -2.8, -4.8 or -6.3 dB respectively.

(2) The interference levels given are those which apply for measurements of the total power received by a single antenna. Less stringent levels may be appropriate for other types of measurements, as discussed in § 2.2. For transmitters in the GSO, it is desirable that the levels need to be adjusted by -15 dB, as explained in § 2.1.